OIPE JC112
NOV 10 2004
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MULTI-POINT SEAT BELT

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

It is an object of the present invention to ensure the restraint of passengers of a transport system, while enhancing the user-friendliness and convenience, and to lower all acceleration-dependent forces imposed on them in order to enhance the survival chance in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) or during in-flight turbulence.

2. Discussion of the Prior Art:

It is known in the prior art to provide for a passenger of a transport system

- a seat-belt-turning mechanism guiding a shoulder belt portion;
- a three-point seat belt (safety belt or lap-shoulder seat belt assembly), mounted in the motor vehicle, consisting of a shoulder belt extending across the upper part of his body and of a lap belt extending across the lower part of his body;
- a two-point seat belt, mounted in the aeroplane, acting as a lap belt extending across the lower part of his body; and
- a suspender- (waist-) belt consisting of several pieces (belt-members).

In order to formulate in single terminology a generalized definition is presented for the proper term:

Definition:	**Proper Term:**
"Transport system"	Motor vehicle or train or ship or aeroplane
"Stiff first transport-system member"	Floor **6** of the transport system adjacent to a first seat-side SR (**Fig.** 1) or seat-cushion frame at the first seat-side or

	mid-tunnel (not drawn) of the motor vehicle adjacent to the first seat-side.
"Stiff second transport-system member"	Floor **6** of the transport system adjacent to a second seat-side SL or seat-cushion frame at the second seat-side or post section **91** (**Figs.** 13, 14) of the motor vehicle adjacent to the second seat-side or side rail of the motor vehicle adjacent to the second seat-side
"Stiff third transport-system member"	Floor **6** of the transport system adjacent to the second seat-side or seat-backrest frame at the second seat-side or post section adjacent to the second seat-side.
"Shoulder-belt-portion deflector"	Belt deflector **5, 5a, 5b** or D-ring **12** (**Figs.** 1, 13, 13a)

It is well known to provide different restraint systems in vehicles, predominantly, three-point seat belts in various types for seats. Evidently, when both shoulders of a passenger, conventionally belted, are not restrained in the event of an arbitrary collision with another vehicle in any direction, shown in **Figs.** 3, 4 and 7, the unrestrained shoulder can always move and/or rotate freely, thereby resulting in severe/fatal injuries in real-world accidents when

- the head crashes into the steering wheel and/or window pane and/or
- the airbag crushes the head, which, loaded by the forces related to pitch-acceleration $\ddot{U}_H$, yaw-acceleration Ö, longitudinal and/or lateral acceleration, is in "oop" (out of position).

Moreover, by the definition of „submarining" the belted passenger submarines (slips downward) under his seat belt thus negating the protective effect of the seat belt.

It is well known to provide two-point or lap seat belts for aeroplane seats as well as mid-portion of the rear seats of motor vehicles. This lap seat belt is far less effective than a three-point seat belt. Due to very large accelerations during a turbulence-related flight the protective effect is very low.

A substantially improved protection is proposed by two different configurations of a one-piece seat belt, exemplified by DE 26 02 875 A1 (**Figs.** 8 to 10). An „X-shaped" restraint is arranged by extending both shoulder belts crosswise over the upper part of the body while the lower part of the body is restrained by the lap belt. Each end of the one-piece seat belt is connected to a belt retractor, fastened in the seat backrest. Two grab rings, positioned to the

headrest, move along the belt. A single or double „X-shaped" configuration is defined by pulling a pair of grab rings and belt portions over the head, shoulders and head rest and engaging them in the corresponding hooks. Due to such intricate operation the seat belt remains unused.

Both harness restraint systems ref. to US 4,488,691 and US 4,738,413 are well-known as suspender belts. Each belt portion of the suspender belt must always be adjusted to an appropriate length depending on the size of the passenger. In general, suspender belts are not popular because finding all the belt portions and connecting all the attachment ends to the release device is a lengthy process, especially in the dark. Moreover, all the belt portions make an untidy impression and are not beneficial for sales.

The biggest drawback is the failure of the restraint. When the belt force exceeds 24,000 N due to lack of vibration-dampening energy absorbers in real-world accidents the passenger are severely/fatally injured. Moreover, he frees himself out of the restraint because the belt elongates at a force-dependant rate over 25 %, shown in Fig. 6 of PCT/US99/13362 (US 09/098,294). Despite being properly restrained and properly seated on a child-seat, perfectly secured to the rear seat, a six-year old kid freed himself out of the restraint and was ejected out of a Toyota Yaris, travelling at 100 km/h, when it laterally slammed into a concrete wall. The accident report "U211002" is incorporated herein.

Ref. to US 4,738,413 a harness restraint system comprises a pair of shoulder belt portions, extending crosswise in an X-shape over the upper part of the body of a crew member, a pair of lower-body belt portions, laterally sustaining the lower part of the body, a pair of leg belt portions, encircling the legs and a single-point release device, which holds the attachment ends of all the belt portions and releases them in a single operation.

Ref. to US 4,488,691 a harness restraint system comprises a pair of shoulder belt portions, extending crosswise in an X-shape over the upper part of the body of a crew member, a pair of leg belt portions, restraining the legs and a release device, which holds the attachment ends of all the belt portions and releases them in a single operation.

US 6,375,270 B1 teaches a seat belt (harness) restraint system, comprising an outboard belt, provided with an outboard buckle member, an inboard belt, provided with an inboard buckle member including a connect mechanism, and belt retractors, provided for all four belt ends. In similar fashion, a harness restraint system ref. to US 6,076,894 comprises a pair of shoulder belts, each provided with a belt retractor, a pair of lap belts, both provided with a common

belt retractor, an outboard buckle member, provided for the outboard lap- and shoulder belts, and an inboard buckle member, provided for the inboard lap- and shoulder belts. When the outboard buckle member is plug-in connected to the inboard buckle member, an „X-shaped" configuration is formed by extending both belts crosswise over the upper part of the body of the passenger and the lower part of the body is restrained.

US 4,652,053 discloses a safety belt system, comprising a pair of shoulder belt portions, restraining only the shoulders of the passenger by means of a pair of upper and lower attaching units, and a lap belt portion, restraining the lower part of the body by means of a lap attaching unit. A pair of rotatory members of the upper attaching unit, when rotated, adapts the distance between the shoulder belt portions to the shoulder width of the passenger. A pair of handling members of the lower attaching units, when rotated, adjusts the length of shoulder belt portions to perfectly restrain the shoulders. Only a butler, standing behind the passenger, could accomplish this time-consuming job. If the car catches fire, the passenger will be burnt alive. For sure, no car company would install such intricate, life-threatening systems.

US-Re 34,051 teaches a safety belt system, comprising a locking device, a pair of shoulder-, lap belt portions and pivot arms, having a pair of second wheels, meshing with the corresponding first wheels, connected to each other by a shaft, laterally located in the lower portion of the seat backrest. One end of each shoulder belt portion is arranged in the seat backrest on the top edge and the others are connected to the free ends of the lap belt portions by a male and female member of the locking device.
Ref. to Figs. 5 and 6 of US-Re 34,051 the cross section of the pivot arm is a little larger than that of the lap belt and the lap belt is arranged along in the pivot arm. This feature is redundant. The flexible pivot arms, serving as the lap belts, can take the function thereof. Under the premise that the lap belts (pivot arms) fit the circumference of the passenger, he is restrained when the pivot arms, located at the sides of the seat backrest in the home position, are moved downwards into the operative position and the male and female members are connected to each other. Because each lap belt has a fixed length, the total length of the lap belts together is too short for an obese passenger and too long for a skinny passenger, who, being loosely restrained, is subjected to submarining. When the belt is loaded up to 24,000 N the wheels and/or the pivot arms are totally deformed.

DE-OS 23 45 847 addresses a height-adjustable upper belt deflector of a shoulder belt portion of a three-point seat belt. This deflector can be adapted to the height of the restrained

shoulders of the passenger by means of a device, moved by a knob along the rails of the belt deflector. The overall stylish impression is spoiled by the belt deflector, rails and device with the knob, all mounted to the seat backrest, and is not beneficial to sales. Moreover, a passenger, sitting on a seat next the one that is equipped with the belt deflector, device and knob, is severely/fatally injured when his head crashes therein.

According to the Claim No 2 of DE-OS 28 13 888 a four-point seat belt for a passenger seated in the rear, defined by the shoulder and lap belt portion of a three-point seat belt and an upper shoulder belt, is made from one piece. Each belt is guided by a belt deflector, adjacent to the lower part of the body of the passenger, and fastened to the vehicle frame. The end portions of the shoulder belt portion and the upper shoulder belt are provided with belt retractors, attached to the seat backrest. In an attempt to step out the passenger has to lower the upper part of his body in order to slip underneath the upper shoulder belt which cannot be removed.

For convenience the belt deflector of the upper shoulder belt is replaced with a latch plate and a corresponding buckle assembly, fastened to the vehicle frame.

DE 196 29 878 A1 teaches a four-point seat belt, comprising two independent three-point seat belts, each having a belt retractor, latch plate, belt deflector and buckle assembly.

US 3,977,696 discloses a four-point seat belt, comprising a three-point seat belt and an upper shoulder belt, both of which, provided with belt retractors, are guided in two rails and driven by electrical motors of a heavy device. When the vehicle roof is totally deformed in a rollover-accident the heavy device crushes the passenger into death.

US 5,123,673 discloses a four-point seat belt, comprising a three-point seat belt and an upper shoulder belt, both of which are provided with belt retractors. An intricate, automatic release device facilitates the release of both buckle assemblies, each equipped with an actuator to release them, regardless of which one is manually released first. When an MB 200 crashes into the vehicle door of an MB S in the city of Geisenheim, a lateral intrusion of about 80 cm is measured. The accident report "U170199" is incorporated herein. When used, the buckle assembly, actuator and other parts, all of which face the totally deformed vehicle door, are destroyed. Hence, the other one does not function. The severely injured driver remains restrained. This rescue workers can't evacuate him within seconds.

In the NHSTA side crash test, which, currently legislated, idealizes an SUV crashing at an angle of 30^0 into a door or vehicle side. As a result, the buckle assembly, actuator and other parts are destroyed.

A complicated latch-plate-feeding device, installed to the side of seat cushion, moves forwards to present the latch plate of the three-point seat belt to the passenger, after having sat down. This device, facing the vehicle door totally deformed in a side crash, is destroyed.

US 5,411,319 discloses a four-point seat belt, comprising two independent three-point seat belts, having a common lap belt portion. Two end belt portions of both three-point seat belts are projected through the seat backrest and attached to a pair of belt retractors, provided with a pair of supporting pieces, which are arranged in a pair of seat rails, are retained thereby and are moveable therealong with the seat when the latter is longitudinally adjusted.

According to the above-mentioned patent docs and appls US 3,977,696, US 5,123,673, US 5,411,319, US 6,076,894, US 6,375,270 B1, DE-OS 28 13 888 and DE 196 29 878 A1 the „X-shaped" configuration, formed by extending both belts crosswise over the upper part of the body, has, in general, the following drawbacks in the event of an accident:

D1. Exemplified in US 6,375,270 B1, all four belt portions of the outboard and inboard belts are retracted to different lengths and blocked by their respective belt retractors within milliseconds in an accident.

D2. Under the load of the same belt force in a front collision the deformation of the seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion. Furthermore, it is impossible to attach a vibration-dampening energy absorber because all four belt ends are occupied.

D3. Exemplified in US 5,411,319, the belt user has to depress two release buttons to release the respective main latch plates **9** from the main buckle assemblies. This two-click operation causes discomfort and hinders rescue work. See countermeasures by means of a single master release button, mentioned below.

A one-piece seat belt **1** (**Fig.** 1) ref. to DE-OS 28 13 888 is equipped with two belt retractors (not drawn), fastened to both belt ends in the seat backrest, and a belt deflector **17**, anchored to the seat-cushion frame **3.3** of the mid-portion of rear seat. The feature, proposed for a child, has the following drawbacks:

D4. When the release button **84** is depressed, the first shoulder belt portion **1.1** gets entangled around the neck of passenger. For the operation of restraining and extending both belt portions into the „X-shaped" configuration, the passenger must lower his head first.

D5. Because all belt ends are occupied, it is impossible to attach vibration-dampening energy absorbers and to adjust the belt to the size of an upper part of the body **95** of an adult.

Generally, a child-seat is fastened by four auxiliary belts to the seat. Despite the „X-shaped" configuration of a one-piece seat belt to restrain a child, sitting in a child-seat, ref. to FR 2 342 872 A1 the problems, associated with the retraction of four auxiliary belts, submarining and energy absorption, remain unsolved in an accident.

Till now, trains, school buses and buses are not provided with restraint systems.

US 6,145,881 discloses a seat-belt tensioner, mounted on the top edge of a seat backrest. In an accident its pyrotechnic piston and cylinder assembly pulls the shoulder belt portion upwardly away therefrom in order to remove slack from the lap- and shoulder belt portions, but both shoulders become unrestrained. As a result, the passenger frees himself from the restraint in a rollover-accident.

When having measured the sound of an inflated airbag of VW Golf IV at an average level of 165 dB Dr. Hohmann from a Swiss Insurer found out the high sound level is responsible for hearing damage. His investigation report is incorporated herein. Beyond doubt, the explosion of the pyrotechnic unit, located very close to the ear, results in hearing damage or deafening. Moreover, the frame of the seat backrest must be reinforced and the bulky seat-belt tensioner needs space and impairs the overall seat design. Till now cars are equipped with seat-belt tensioners, installed beneath the seats or in the B-post sections in order to insulate the sound and avoid hearing damage.

A D-ring ref. to DE 40 10 452 A1 is in contact with the shoulder belt, when the passenger is thrown forward, but it is moved up to intercept the head, when the passenger is thrown backward.

Under constraint of great deformation of the post section, in which an extending belt portion **1.4** of the three- or multi-point seat belt **1e, 1**, equipped with a belt retractor **13**, having a clamping device, is arranged (**Figs.** 1, 2), the shoulder belt portion, loosely guided by a conventional height-adjustable D-ring **12**, strangulates the neck of the belted passenger and/or injures the aorta of his neck in real-world side crashes, causing instant death.

US 5,599,070 teaches a seat-belt-turning mechanism, fixed to the seat backrest on the top edge and comprising eight parts, one of which is a turning member, by which the shoulder belt portion **1.2** is guided and turned into an extending belt portion **1.4**, which is guided by a sheath and connected to a belt retractor, fixed to a frame of the seat backrest. The height-adjustable, one-piece belt deflector **5, 5a, 5b** (**Figs.** 1, 13, 13a) is far cheaper and more effective than that seat-belt-turning mechanism with fixed height.

Any belted passenger, lying in a sleeping position ref. to DE 37 41 831 C2, submarines when being loaded by great mass inertia force „S_y" in the direction „L_y" (**Fig.** 12b) in the event of accident.

SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to provide for passengers of a transport system seat belts, each equipped with a belt retractor, solely responsible for retraction, blocking and tightening or for protraction, a lower belt deflector to loosely guide a belt portion and multi-attachment points (multi-points of restraint), and to restrain every passenger in multi-attachment points, in order to lower and distribute the acceleration-dependent loads, shown in **Fig.** 3 and **Tables** 1 to 3, to the multi-attachment points in the event of any accident or during in-flight turbulence. Nowadays, belt tighteners are incorporated into belt retractors, for example, of MB 500 SL in order to save costs, assembly time and space.

A second object of the present invention resides in a single master release button, which, when depressed, releases all latch plates from the buckle assemblies and/or returns the belt-feeding device to the home (resting) position. In emergency cases paramedics and fire-fighters can easily rescue the injured passengers.

A third object of the present invention resides in the conventional three-point seat belt associated with new parts, shown in **Fig.** 2, to serve as a transition product until multi-point seat belts are put into production.

INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides substantially improved restraint, including the following features:

a) The survival chance is enhanced by the restraint of

* both shoulders and the torso, when the passenger is thrown forward (**Fig.** 4, **Table** 3) and/or subjected to the yaw Ö-acceleration-dependent torque $T_{ö}$, and
* both thighs and the lower part of the body to prevent submarining (**Fig.** 12b).

b) Because the belt retractor is attached to one belt end, a number of sets of vibration-dampening energy absorbers ref. to US serial no. 09/554,464 (WO 99/24292, PCT/DE98/03271, European Patent EP 1 037 771 B1, German Patent DE 197 58 498 C2, CA pending patent 2,314,345) or German Patent DE 197 58 497 C2 can be attached to the other belt end (**Figs.** 11a, 11b, 15), thus gradually absorbing large impact energy below the respective injury-related values and dampening vibration. The inventor of the present application has submitted those patent documents and applications to CIPO as well as USPTO. The vibration-dampening energy absorber consists of a number of clamping elements, having sites of predetermined fracture, and a retaining element, which, fastened to the seat-backrest frame and/or seat-cushion frame, can serve as an integral part thereof.

c) Owing to the different positions of pairs of upper buckle assemblies, in plug-in connection with the respective belt-detachable latch plates **25** (**Fig.** 16), passengers of different body proportions can adjust the belts by themselves. Moreover, the seats, equipped therewith, can be modified to be used by adults or children, thus increasing the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig.** 20.

d) In resting position the shoulder latch plate **2**, in plug-in connection with an assisting buckle assembly **16, 16a, 16b,** fastened to the seat cushion **3.1**, B-, C-post section or seat backrest (**Figs.** 1, 2), is easily accessed by the passenger wanting to use the belt.

e) The seat belt can be equipped with a belt-feeding device, manually operated or by a drive apparatus, for example, hydraulic-piston cylinder unit, electrical motor (not drawn), which enhances the convenience and comfort of the user. This drive apparatus is switched on by a pressure sensor, built to the seat, or an existing switch such as lighting-, door- or touching switch. If the belt is not engaged within a dwell time, a control device is activated to switch off the drive apparatus and to reposition the belt-feeding device in the resting position.

f) For the convenience of the passenger, when stepping out, or for the quick-rescue of the injured passenger in accidents, the master release button **84** of the buckle assembly **9.1** is depressed to release all latch plates from the buckle assemblies and/or to return the belt-feeding device to the resting (home) position.

g) Use of the height-adjustable shoulder-belt-portion deflector **5b** (**Fig.** 13) or of the shoulder-belt-portion deflector **5** (**Fig.** 1), each upper portion of which is projected through the top edge of the seat backrest, makes the conventional height-adjustable D-ring **12**, attached to the B-, C-, D-post section, shown in **Fig.** 1, unnecessary. If the shoulder-belt-portion deflector **5, 5b** is not height-adjustable but movable, it can be connected to vibration-dampening energy absorbers, ref. to US-serial number 09/554,464 (EP 1 037 771 B1, DE 197 58 478 C2, CA pending patent 2,347,040), which absorb energy and dampen vibration when the shoulder belt portion moves it up.

In another embodiment the shoulder-belt-portion deflector **5a** (**Fig.** 13a) can be rigidly attached to the head rest **3.6a**. Any adjustment of the height of the head rest **3.6a** to the head automatically adjusts the height of the shoulder-belt-portion deflector to the shoulder.

h) Owing to the different positions of anti-submarining buckle assemblies, in plug-in connection with the respective anti-submarining latch plates, passengers of different body proportions, thighs and weight can adjust the length of the anti-submarining belt portions **1.3R, 1.3L** by themselves. In contrary to Volvo's WHIPS, the adult seats, equipped therewith, can be modified for children and vice versa, thus increasing the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig.** 20. In another embodiment the length-adjustable belt of the anti-submarining seat belt assembly **8b, 8c** facilitates, for example, a female passenger to adapt the belt length to her long gown or to herself, when lying in sleeping position (**Figs.** 1, 12b).

For safety reasons and easy access the anti-submarining latch plates **11, 25**, when not being used, are stored in a storage box **25.5** (**Fig.** 20). The belt-detachable anti-submarining latch plates **25** (**Figs.** 12b, 16) are attached to the lap belt portion when needed.

For the convenience of the passenger, when stepping out, or for a fast rescue of the passenger injured in an accident, the master release button **84** of the buckle assembly **9.1** is depressed to release all latch plates from the buckle assemblies.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying tables and drawings with reference to the xyz global coordinate system:

Table 1 shows test data such as left / right thigh-force, belt force and pitch-angle of driver and co-driver in 50% offset crash test of several European vehicles at crash speed of 55 km/h.

Table 2 shows yaw angle O of driver / co-driver in a 50% offset crash tests.

Table 3 shows test data of the safest child-restraint system Chico Shuttle® at the converted velocity of 55 km/h in comparison with the safest vehicle among them listed in **Table** 1.

Fig. 1 is a perspective view of a 1st embodiment of a height-adjustable shoulder-belt-portion deflector **5**, of anti-submarining buckle assemblies **7, 8, 8a to 8d**, attached to the seat, and of a seat with buckle assemblies attached to the seat backrest and seat cushion as well as of a 1st embodiment of a restraint system consisting of a multi-point seat belt **1**, shoulder-belt deflector **5**, D-ring **12**, latch plate **11** moveable along the lap belt, shoulder latch plate **2** of belt end portion, in the direction of arrow „Z" in plug-in connection with an upper buckle assembly **4**, and a seat belt in X-shape, formed by crossing the first and second shoulder belt portions **1.1, 1.2**.

Fig. 2 is a perspective view of a seat and of a 2nd embodiment of a restraint system, comprising three-point seat belt **1e,** having a transition latch plate **2**, which will be inserted into a transition buckle assembly **4e** of a shoulder belt **1.11**, pulled in the direction of arrow „Z".

Fig. 3 illustrates load cases I, II and III in z-y plane in the event of a real-world accident.

Fig. 4 is a perspective view of a restrained dummy thrown forward in VW Polo® in a 50% offset crash test.

Fig. 5 illustrates a yaw-acceleration Ö and yaw-angle O of a vehicle about the vertical axis „z_A" in a 50% offset crash test of two identical vehicles.

Fig. 6 illustrates a yaw angle O of vehicle about the vertical axis „z_A" in a 50% offset crash test into a stiff barrier.

Fig. 7 illustrates four collision types „U1" to „U4" ref. to the research work of Institute of Vehicle Safety, a Dept. of German Insurers Association.

Fig. 8 is a front view of a seat belt ref. to DE-OS 26 02 875 in the home position.

Fig. 9 is a front view of a double X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 10 is a front view of a single X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 11a is a schematic, perspective view of a 1st embodiment of a buckle assembly **4a**, equipped with release cable **4.2**.

Fig. 11b is a schematic, perspective view of a 2nd embodiment of a buckle assembly **4b**, equipped with an electrical release-motor **4.2b**.

Fig. 12a is a perspective view of a 1st embodiment of a belt-catching member **20.7a**.

Fig. 12b is a perspective view of a 2nd embodiment of a belt-catching member **20.7** and of a anti-submarining latch plate **11, 25** of a lap belt portion **1.3** in plug-in connection with the anti-submarining buckle assembly **8**.

Fig. 13 is a perspective view of a 1st and 2nd embodiment of a belt-feeding device and spatially-adjusting belt-feeding device **20a** from the resting position to the operative position and of a height-adjustable shoulder-belt-portion deflector **5b** as well as of a 2nd embodiment of a height-adjustable belt deflector **5b** having a locking handle **5.2**.

Fig. 13a is a perspective view of a 3rd embodiment of a shoulder-belt-portion deflector **5a** fastened to a head rest **3.6a**.

Fig. 14 is a schematic view of the 2nd and a 3rd embodiment of spatially-adjusting belt-feeding devices **20a** and **20b** in kinematics from the operative position to the resting position in x-y plane.

Fig. 15 is a schematic, perspective view of a seat backrest, equipped with a second belt retractor **13a**.

Fig. 16 is a schematic, perspective view of a belt-detachable U-shaped latch plate **25** and a 1st and 2nd embodiment of a height- and width-adjusting mechanism **27, 27a**.

Fig. 17 is a cross-sectional view of the 1st embodiment of the height- and width-adjusting mechanism **27** along the line I-I of **Fig.** 16.

Fig. 18 is a cross-sectional view of the height- and width-adjusting mechanism **27** along the line II-II of **Fig.** 17.

Fig. 19 cross-sectional view of the 2nd embodiment of the height- and width-adjusting mechanism **27a** along the line I-I of **Fig.** 16.

Fig. 20 is a front view of the seat **3a to 3d**, in which the restraint systems **1a to 1d,** storage boxes **25.5** and the anti-submarining seat-belt assemblies are integrated, for passengers of different weights, different circumference of thighs and different body proportions (sizes), where anti-submarining buckle assemblies are in plug-in connection with the anti-submarining latch plates **11, 25**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF

THE INVENTION

The advantages of the preferred embodiments in the Chap. "INDUSTRIAL APPLICABILITY" are outlined hereinafter with regard to the functions and features thereof.

The method of the present invention capitalizes on the premise that a seat belt is employed to restrain a passenger in at least four attachment points of the seat to distribute all acceleration dependant loads, particularly the yaw Ö-acceleration-dependent torque $T_{ö}$, thereto in an accident, thus ensuring the operation of a single belt retractor to pre-tension (bias) as well as tension the belt, restraining both shoulders, an upper- and a lower part of the body and lowering all the loads, in particular, in co-operation with the energy-absorption when a number of sets of vibration-dampening energy absorbers is put into use. This will be apparent when all forces, imposed on the belted passenger, shown in **Figs.** 3 and 4, are formulated in the event of a front collision, where the loads of the mass D_S of the torso are lowered because

- the forward motion „w_V" is minimized, thus substantially reducing the pitch-acceleration $Ü_H$ and force F_{Hy} of the mass D_H of the head, and
- the yaw-acceleration Ö is minimized, thus substantially reducing the torque $T_{ö}$, imposed on the head. Great torque $T_{ö}$ is the most latent force, responsible for sudden death.

To a great extent massive head injuries can be avoided.

Load case I in z-y plane: The rotating mass D_S rotates about the rotating axis „S" at the pitch-angle U_S and mass D_H about the rotating axis „z" at the pitch-angle U_H in **Table** 1, thereby resulting in the pitch-accelerations $Ü_S$, $Ü_H$ and rotating forces F_{Sy}, F_{Hy}. The addition of both rotating forces yields the force F_V linked to the forward motion w_V of passenger, shown in **Fig.** 4.

Load case II in x-y plane: The upper part of the body is subjected to the torque $T_{ö}$, exerted by the yaw-acceleration Ö about the rotating axis „z". When the upper part of the body is restrained in an X-shape, the torque is substituted by a pair of forces.

Load case III in x-z plane: The rotating mass D_S rotates about the rotating axis „S" at the rotating angle U_y and mass D_H about the rotating axis „z" at the rotating angle U_{Hy}, thereby resulting in the rotating accelerations $Ü_y$, $Ü_{Hy}$ and rotating forces D_{Sy}, D_{Hy} (not drawn). In a rollover-accident the passenger is subjected to the load F_{Sz}.

Load case IV: In turbulence-related vibrations of an aeroplane the load D_{Sy} together with D_{Hy} takes the form of periodical load $\pm F_{Hx}$, F_{Sz} of $\pm F_{Sz}$, $T_{\ddot{o}}$ of $\pm T_{\ddot{o}}$, S_y of $\pm S_y$ and F_{Sy} together with F_{Hy} of $\pm F_V$.

The restraint system, illustrated in **Fig.** 1, is provided with a conventional belt retractor **13** having a clamping device, housed in the B-, C-, D-post section or in the seat backrest **3.2** at one of both seat-sides SL and SR of a seat and connected to the second belt end EL. The first belt end ER is provided with a shoulder latch plate **2**, which is retained, loosely guided by a lower belt deflector **17**, fastened to the vehicle floor, and inserted into one of the upper buckle assemblies **4, 4a to 4c, 14, 14a, 18, 18a, 18b**, arranged in or to the seat backrest **3.2**. In all embodiments a main latch plate **9** can move along the seat belt **1** between both belt ends EL and ER. When plug-in connecting the shoulder latch plate **2** (in the direction of arrow "Z") to the buckle assembly **4** and the main latch plate **9** to the main buckle assembly **9.1**, an X-shaped restraint of the upper part of the body and both shoulders as well as a restraint of the lower part of the body are accomplished by the first and second shoulder belt portion **1.1, 1.2** and the lap belt portion **1.3**.

In the 2nd embodiment, shown in **Fig.** 2, a transition product, comprising a conventional three-point seat belt **1e** and new parts, has to be invented due to the delay in producing multi-point seat belts **1**. The floor fitting (not shown) is replaced by the lower belt deflector **17**. The first belt end of the lower first shoulder belt portion **1.11** is provided with transition latch plate **2**. The first belt end of an upper first shoulder belt **1.12** and the second belt end are equipped with a transition buckle assembly **4e**, having a transition release button **84c**, and with a second belt retractor **13a**, arranged in the seat backrest **3.2**. Due to the second belt retractor the transition buckle assembly **4e**, acting as the shoulder latch plate **2, 2a** of multi-point seat belt, is located in a home position on a seat-backrest aperture of the seat at the first seat-side. Hence, the seat-design is not compromised. In a coupling position the restraint in an X-shape is defined by plug-in connection of transition latch plate **2** with the transition buckle assembly **4e**, pulled out from the seat-backrest aperture, wherethrough a transition portion of the upper first shoulder belt is projected. This upper first shoulder belt and the lower first shoulder belt portion **1.11** define the first shoulder belt portion **1.1**. In order to resolve the above-mentioned drawback **D1**, the spring force of the second belt retractor **13a**, to retract the upper first shoulder belt **1.12**, released by depressing the transition release button **84c**, is far less than that

of the belt retractor **13**. Although the circumference of the restrained passenger varies, depending on the clothes worn, and the seating-position differs the lower first shoulder belt portion **1.11** always projects through the lower belt deflector **17** at a sufficient length of "l_1" to maintain the function of the belt retractor **13** to retract, to block the belt as well as to release the retracted belt during the journey and the function of the belt tightener (not drawn), incorporated in the belt retractor, to forcefully retract (withdraw) and tighten the belt in an accident. The transition release button **84c** of transition buckle assembly **4e**, arranged to or in the seat, can be controlled neither by release cable **4.2** nor by electrical release-motor **4.2b**. It can only be activated by electrical signals emitted from the master release button **84** when depressed.

The second belt end of upper first shoulder belt **1.12** can be connected either to a coupling fitting **1.2a, 1.2b (Figs.** 11a, 11b, 15) or to the second belt retractor **13a** having a coupling fitting **1.2b (Fig.** 15) in order to receive a number of vibration-dampening energy absorbers to dissipate great impact energy and dampen strong vibration.

In another embodiment an upper first shoulder belt **1.12a** consists of the transition buckle assembly **4e** and a shoulder latch plate **2a** (not shown), similar to latch plate **2 (Fig.** 1), which is plug-in connected to

- the upper buckle assembly **4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3**, arranged to the seat backrest, in operative position or
- the assisting buckle assembly **16, 16a, 16b** in resting position.

When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, the lower belt deflector **17**, the second belt retractor **13a** and by a variety of one-piece, detachable, upper first shoulder belts **1.12a** with different lengths. Furthermore, the latch plate **2a** can be detached from the buckle assembly by depressing the master release button **84**.

A first shoulder belt portion **1.1** is defined by the upper first shoulder belt **1.12a** and the lower first shoulder belt portion **1.11**.

With an expensive modification or in new transport system the convenience and comfort are enhanced by the use of belt-feeding device **20, 20a to 20d**, where the upper first shoulder belt **1.12, 1.12a** with transition buckle assembly **4e** is a part of the belt-feeding device.

Beyond doubt, the three-point seat belt **1e** in plug-in connection with the upper first shoulder belt **1.12, 1.12a** is suited as a temporary solution for the multi-point seat belt **1, 1a to 1d**.

In the above-mentioned embodiments to resolve the above-mentioned drawback **D4** the upper part of the body is restrained by extending the shoulder belt portions crosswise in an X-shape

c1) when at least one shoulder latch plate **2** is plug-in connected to the upper buckle assembly of the seat backrest; *or*

c2) when a shoulder latch plate **2**, arranged to the first belt end ER of the first shoulder belt portion **1.1** of a belt-feeding device **20a**, **20b**, is plug-in connected to the upper buckle assembly of the seat backrest.

The feature ref. to c2) has the advantage that the common practise of operating the conventional three-point seat belt is preserved.

In order to resolve the above-mentioned drawbacks **D2** and **D5** great energy is absorbed and strong vibration is dampened by a large number of vibration-dampening energy absorbers connected to the respective upper buckle assemblies **4, 4a to 4c, 4e, 7, 8, 8a to 8d, 9.1, 14, 14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3** (**Figs.** 1, 20) to which latch plates are plug-in connected.

The lower belt deflector **17** comprises a housing having an attachment hole to receive a pin **17.1**. Both members can be made in one piece. If necessary, the pin **17.1** is surrounded by a sleeve **17.2** of plastics, having corrugation or knobs, which is a common part of the conventional D-ring **12**. This D-ring **12** can be replaced by the lower belt deflector **17**. The aperture of the belt deflector **17** to loosely guide the belt portion is dimensioned so as to retain the latch plate **2** in resting position, thus allowing the use as a three-point seat belt.

To prevent the entanglement of the first shoulder belt portion **1.1** behind the seat, particularly when positioned furthest forward, that first shoulder belt portion **1.1** in resting position is intercepted by the belt-catching member **20.7, 20.7a** (**Figs.** 12a, 12b). When the second shoulder belt portion **1.2** and the extending belt portion **1.4** are arranged to the post section, both shoulder belt portions can also be intercepted by the belt-catching member.

When the seat **3c** (**Fig.** 20) has a high seat backrest, the curved guide tube **20.1** of belt-feeding devices **20a** (**Fig.** 13) can be modified to a straight-running operating arm **20.2** of the belt-feeding device **20**.

In the 2nd or 3rd embodiment the belt-feeding device **20a** or **20b** is provided with a height-adjustable belt housing **20.4a** and radial-adjustable tube **20.3** (**Figs.** 13, 14). Both devices

differ from each other by the position of the guide tubes **20.1** on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube **20.1** of the belt-feeding device **20a** is pivotally attached in a stiff supporting tube **3.61** of the head rest **3.6** with fixed height .

The height of „Δh" of belt housing **20.4a**, having a latch plate **2**, plug-in connected to any buckle assembly **4, 14, 18**, is adjustable when the passenger moves two openings, facing each other, along the operating arm **20.2a**. Alternatively, the passenger can move a handle **5.2**, such as locking handle **27.5** of the height- and width-adjusting mechanism **27, 27a (Figs.** 13, 17 to 19), to adjust the height of „Δh" of the shoulder-belt-portion deflector **5b**.

In order to ensure the operation of pro- and retracting any shoulder-belt portion, arranged in the seat backrest **(Figs.** 8 to 10), is loosely guided by a shoulder-belt-portion deflector which, having a rectangular shape, is usually pressed in a seat-backrest aperture of the seat backrest on the top edge.

The belt-feeding devices **20a, 20b** have to meet the following criteria:

- Passengers can freely get in and out of the vehicle compartment thanks to the distances of „a" and „b" between the post section **91** and operating arm **20.2a (Fig.** 14) in resting position; and
- the device, when rotated, does not interfere with the head rest **3.6** owing to the clearance (height-difference) about „Δh_K" and with the head of the passenger with/without hat **92**.

Regarding the kinematics of the height-adjustable belt housing **20.4a** with the latch plate **2** from the operative position to the resting position, the trajectories of „Ba2" and „Bb" are well clear of the passenger's head thanks to a radial-adjustable tube **20.3** incorporated into the operating arm **20.2a**. Without the radial-adjustable tube **20.3** the operating arm in the trajectory of „Ba1" would interfere with that hat.

Upon plug-in connection of the latch plate **2** with the buckle assembly **4, 4a, 4b** the belt end ER of belt portion **1.1** is connected to the coupling fitting **1.2a, 1.2b (Figs.** 11a, 11b), whereto a number of vibration-dampening energy absorbers is attached to absorb energy and dampen vibration. In a cost-saving embodiment without the latch plate **2** and buckle assembly, the belt end ER of belt portion **1.1** is directly connected to the coupling fitting **1.2a** or **1.2b (Fig.** 15) to receive vibration-dampening energy absorbers, the retaining elements of which are fastened to the seat backrest frame **3.4d**. In order to absorb great energy and damp strong

vibration during in-flight turbulence or in the accident of a fast speeding car or high-speed train, the belt retractor **13**, coupling fitting **1.2b** of which is connected to vibration-dampening energy absorbers, is moveably attached to the oblong holes of a stiff plate **13.3**, fastened to the seat-backrest frame at the seat-side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

In the 1st to 3rd embodiment (**Figs.** 11a, 11b, 18) the buckle assembly **4a, 4b, 4c** is form- and/or force-locking connected to the seat-frame of the seat.

For the convenience of the passenger when egressing from the vehicle and in cases of emergency the following embodiments of detachment are proposed:
To disconnect the latch plates **2, 11** and/or **25** from the buckle assemblies **4, 14, 14a, 15, 15a** (**Fig.** 1) and pairs of supplement upper buckle assemblies **18 / 19, 18a / 19a, 18b / 19b, 18.1 / 19.1 to 18.3 / 19.3** (**Fig.** 20) of the seat arrangement, particularly for children, as well as from the anti-submarining buckle assemblies **7, 8, 8a to 8d** (**Figs.** 1, 12b), the master release button **84**, when depressed, activates the release cables **4.2** and/or electrical release-motors **4.2b**, which pull the release button **84a** and/or **84b** of the buckle assemblies (**Figs.** 11a, 11b, 18). When depressing the master release button **84** the drive apparatus of the belt-feeding device **20, 20a, 20b** returns the first shoulder belt portion **1.1** from the operative position to the resting position.

In the 1st embodiment (**Figs.** 17 to 19) the height- and width-adjusting mechanism **27** comprises a frame **29**, buckle-assembly unit **18.3, 19.3**, a pair of tubes **27.4**, members **27.5 to 27.9** and a pair of tubes **27.1** having a plurality of vertical locking slots, in form- and force-locking connection with an angle fitting **26a**. The frame **29** consists of a pair of outer tubes **27.3**, a pair of tubes **27.2** and a connecting member of all tubes. The locking handle **27.5** is form- and force-locking connected to the slots of the inner tubes **27.4**.
These inner tubes **27.4**, inserted into the outer tubes **27.3**, are pre-loaded by the tube-springs **27.6**. Each tube-spring **27.6** on a sleeve **27.7**, secured by pin **27.8**, protruding through the holes of the inner tube **27.4**, presses against the spring rest **27.9** of the outer tube **27.3**.

The locking handle **27.5** is in engagement with a pair of vertical locking slots of tubes **27.1**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of mechanism **27** and buckle assembly can be adjusted

The outer tube **27.3** is provided with a plurality of horizontal locking slots q, r, s etc., drawn with dotted lines, shown in **Figs.** 17, 19.

After the pawl **18.10**, pre-loaded by the pawl-spring **18.5**, is detached from the horizontal locking slot r by its movement in the direction of arrow (**Fig.** 18), the housing **18.12** of the buckle-assembly unit **18.3, 19.3**, form-locking connected to the upper buckle assembly **4c** thereof, can be moved along both outer tubes **27.3**.

Belt-detachable U-shaped latch plates **25** offer the passengers a feature to adapt their body proportions to the appropriate pair of supplement upper buckle assemblies into which the latch plates **25** are inserted (**Figs.** 16, 20). Any belt portion, such as **1.1, 1.2**, is loosely guided thereby, secured by a quick-release pin **25.1** thereof and detached therefrom by pulling the quick-release pin. To adapt a small body proportion of, say, a child, far lower than the upper buckle assembly **4** suited for adults, at least one pair of belt-detachable latch plates **25** are plug-in connected to one of the pairs of supplemental upper buckle assemblies **18 / 19, 18a / 19a, 18b / 19b, 18.1 / 19.1 to 18.3 / 19.3,** arranged to the seat backrest at the first and second seat-side (**Figs.** 1 and 20). For safety reasons and easy access the belt-detachable latch plates **25**, when not being used, are stored and secured in a storage box **25.5** of the seat (**Fig.** 20).

For juxtaposed seats in vehicles, buses, trains and aeroplanes it is recommended to use a single locking handle **27.5** to operate the 2nd embodiment of the height- and width-adjusting mechanism **27a** of each seat **3c**, having, for example, three pairs of openings **18.1 /19.1 to 18.3 / 19.3** to receive a pair of shoulder latch plates (**Figs.** 19, 20).

The frame **29a** consists of two pairs of outer tubes **27.3**, two pairs of tubes **27.2**, a pair of connecting members of all tubes and members **18.3, 19.3, 27.6 to 27.9a, 27.11**, attached to the outer tubes **27.3**.

The locking handle **27.5** is form- and force-locking connected to slots of the inner tubes **27.4** by the pins **27.12**. After inserting these inner tubes into the outer tubes **27.3** the locking plate **27.10** is form- and force-locking connected to the slots of the inner tubes and to the pins **27.12**.

After securing the spring rest **27.9a** by the retaining rings **27.11** and both sleeves **27.7a** by the pins **27.8**, protruding through the holes of inner tubes **27.4** and oblong holes of outer tubes

27.3, the inner tubes with locking handle **27.5** are pre-loaded by tube-springs **27.6**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of height- and width-adjusting mechanism **27a** can be adjusted.

In an embodiment the release button **84f** (not drawn), **84e** of free-moving anti-submarining buckle assembly **8b, 8c (Fig.** 1), whose housing is free-moving on the seat cushion and whose length-adjustable belt is fastened to the seat frame, can be controlled neither by a release cable **4.2** nor by an electrical release-motor **4.2b**. Hence, the release button **84e, 84f** can only be activated by an electrical signal emitted from the master release button **84,** when depressed, to remove the protection from submarining.

Because the reel (spool) of the conventional belt retractor can accommodate only a limited length of belt, it is possible that the length of the seat belt for the sleeping position is insufficient. The length-adjustable belt compensates for the length of seat belt **1, 1e** and accommodates the passenger, particularly when being obese, in all positions between the sleeping and normal position.

An anti-submarining buckle assembly **8d**, provided with a release button **84d**, is attached to the front portion of the seat cushion. This feature facilitates the obese passenger or a lady in a gown to restrain the thighs by plug-in connecting the anti-submarining latch plate **11** thereto.

By law passengers travelling in a motor vehicle or experiencing flight-turbulence must remain belted. The need for a belted mother to turn around becomes apparent, when she must attend to her children sitting on the rear seat. The separately operated release buttons **84o, 84d, 84e, 84f**, when depressed, detach only the anti-submarining latch plates **11, 25** of the lap belt portions from the assemblies **7, 8, 8a to 8d (Figs.** 1, 12b and 20) to free the mother and/or children from the anti-submarining protection while the mother and/or children remain belted. The anti-submarining buckle assemblies **7, 8, 8a**, whose housings are located in the seat cushion **3.1, 3.1a to 3.1d**, have the common release button **84o** on the seat.

When depressing the master release button **84** the drive apparatus of the belt-feeding device **20, 20a to 20d** returns the first shoulder belt portion **1.1** from the operating position to the resting position.

Although the present invention has been described and illustrated in detail, it is clearly understood that the terminology used is intended to describe rather than limit. Many more

objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims, the present invention may be practised otherwise than as specifically described and illustrated.

What is claimed:

42. A multi-point seat belt for increasing survival chance of a passenger of a transport system in an accident or during in-flight turbulence, comprising

a first and second shoulder belt portion, a lap belt portion and an extending belt portion **(1.1 to 1.4)** and a first and second belt end (ER) and (EL), where the extending belt portion **(1.4)**, having the second belt end (EL), loosely guided by a shoulder-belt-portion deflector **(5, 5b, 12)** and equipped with a belt retractor **(13)**, having a clamping device, is attached to a stiff third transport-system member, generally representing a floor of the transport system adjacent to a second seat-side or a seat-backrest frame at the second seat-side or a post section of a motor vehicle adjacent to the second seat-side ;

a main buckle assembly **(9.1)** having a master release button **(84)** and attached to a stiff first transport-system member, generally representing the floor of the transport system adjacent to a first seat-side or a seat-cushion frame at the first seat-side or a mid-tunnel of a motor vehicle adjacent to the first seat-side;

at least two latch plates **(2, 2a, 9, 11, 25)**, the first of which is a main latch plate **(9)**, moveable either along the lap belt portion **(1.3)** or along the second shoulder belt portion **(1.2)**, and the second of which is a shoulder latch plate **(2, 2a)** of the first belt end (ER) of the first shoulder belt portion **(1.1)**;

a lower belt deflector **(17)**, deflecting and loosely guiding the lap belt portion **(1.3)** or the first shoulder belt portion **(1.1)** and attached to a stiff second transport-system member, generally representing the floor of the transport system adjacent to the second seat-side or the seat-cushion frame at the second seat-side or the post section of the motor vehicle adjacent to the second seat-side or a side rail of the motor vehicle adjacent to the second seat-side; and

at least one upper buckle assembly **(4, 4b, 4c, 4e, 14, 14a, 18, 18a, 18b, 18.1 to 18.3)**, located on the seat backrest at the first seat-side;

whereby

a lower part of the body **(96)** of the passenger and an upper part of the body **(95)** are restrained by the lap- and second shoulder belt portions **(1.3, 1.2)** when the main latch plate **(9)** is plug-in connected to the main buckle assembly **(9.1)**; and

the upper part of the body is restrained by the first and second shoulder belt portions, both **(1.1, 1.2)** extending crosswise in an X-shape when the shoulder latch plate **(2, 2a)** is plug-in connected to the upper buckle assembly.

43. The multi-point seat belt according to claim **42**, wherein the master release button **(84)**, when depressed, releases all the latch plates from the respective buckle assemblies.

44. The multi-point seat belt according to claim **43**, wherein the master release button **(84)** is provided with release cables **(4.2)** connecting to release buttons of the upper buckle assemblies.

45. The multi-point seat belt according to claim **43**, wherein the master release button **(84)** is provided with release wires connecting to electrical release-motors **(4.2b)** of release buttons of the upper buckle assemblies.

46. The multi-point seat belt according to claim **42**, wherein the multi-point seat belt **(1, 1a to 1d)** consists of a three-point seat belt **(1e)** and an upper first shoulder belt **(1.12a)**,

a first belt end of which and a second belt end are provided with a transition buckle assembly **(4e)** and the shoulder latch plate **(2a)**, plug-in connected to the upper buckle assembly; and

a transition latch plate **(2)** is attached to a first belt end of a lower first shoulder belt portion **(1.11)** of the three-point seat belt **(1e)**;

whereby

the passenger is restrained when the main latch plate **(9)** and the transition latch plate **(2)** are plug-in connected to the main buckle assembly **(9.1)** and the transition buckle assembly **(4e)**, where the lower first shoulder belt portion **(1.11)** projects through the lower belt deflector **(17)** at a sufficient length (l_1) needed for the belt retractor to retract the first shoulder belt portion **(1.1)**, defined by the lower first shoulder belt portion **(1.11)** and the upper first shoulder belt **(1.12a)**, in the accident.

47. The multi-point seat belt according to claim **42**, wherein the multi-point seat belt **(1, 1a to 1d)** consists of a three-point seat belt **(1e)** and an upper first shoulder belt **(1.12)**,

a first belt end of which is provided with a transition buckle assembly **(4e)**, having a transition release button **(84c)**, acting as the upper buckle assembly **(4)** and located in a home position on a seat-backrest aperture of the seat backrest at the first seat-side, and a second belt end is arranged to the seat-backrest frame at the first seat-side; and

a transition latch plate **(2)** is attached to a first belt end of a lower first shoulder belt portion **(1.11)** of the three-point seat belt **(1e)**;

whereby

in a coupling position the passenger is restrained when the main latch plate **(9)** and the transition latch plate **(2)** are plug-in connected to the main buckle assembly **(9.1)** and the transition buckle assembly **(4e)**, pulled out from the seat-backrest aperture, wherethrough a transition portion of the upper first shoulder belt is projected, where the lower first shoulder belt portion **(1.11)** projects through the lower belt deflector **(17)** at a sufficient length (l_1) needed for the belt retractor to retract the first shoulder belt portion **(1.1)**, defined by the lower first shoulder belt portion **(1.11)** and the upper first shoulder belt **(1.12)**, in the accident.

48. The multi-point seat belt according to claim **47**, wherein the second belt end of the upper first shoulder belt **(1.12)** is provided with a second belt retractor **(13a)**, arranged in the seat backrest **(3.2)** at the first seat-side, and having a spring force, which is less than that of the belt retractor **(13)**;

whereby

in the coupling position the belt retractor pulls the upper first shoulder belt out from the second belt retractor through the seat-backrest aperture or

in the home position the transition buckle assembly **(4e)**, released by depressing the transition release button, is pulled by the second belt retractor until being located on the seat-backrest aperture.

49. The multi-point seat belt according to claim **48**, wherein the transition buckle assembly is provided with an electrical release-motor **(4.2b)**, which, when receiving an electrical signal from the main buckle assembly resulting from depressing the main release button releasing the main latch plate, pulls the transition release button to release the transition latch plate.

50. The multi-point seat belt according to claim **42**, wherein the lower belt deflector **(17)** comprises a housing, having an attachment hole, and a pin **(17.1)**, attached in the housing to form an aperture which loosely retains the released shoulder latch plate **(2, 2a)**.

51. The multi-point seat belt according to claim **50**, wherein the pin **(17.1)** is surrounded by a sleeve **(17.2)**.

52. The multi-point seat belt according to claim **51**, wherein the lower belt deflector **(17)** is made from one piece.

53. The multi-point seat belt according to claim **43**, wherein the released shoulder latch plate is plug-in connected to an assisting buckle assembly **(16, 16a, 16b)**, having an easily-accessible release button and attached to a seat, where the passenger, wanting to use the multi-point seat belt, depresses the easily-accessible release button to release and access the shoulder latch plate.

54. The multi-point seat belt according to claim **43**, wherein the released shoulder latch plate is plug-in connected to an assisting buckle assembly **(16, 16a, 16b)**, having an easily-accessible release button and attached to the post section, where the passenger, wanting to use the multi-point seat belt, depresses the easily-accessible release button to release and access the shoulder latch plate.

55. The multi-point seat belt according to claim **43**, wherein a belt-feeding device **(20a, 20b)** consists of

a belt housing **(20.4a)**, to which the shoulder latch plate **(2, 2a)** of the first shoulder belt portion **(1.1)** is attached; and

an operating arm **(20.2a)**, to a first end of which and a second end are connected to the belt housing and a guide tube **(20.1)**, pivotally attached in a supporting tube of the seat backrest;

whereby the shoulder latch plate **(2, 2a)** is inserted into and connected to the upper buckle assembly **(4, 14, 18)** and the first shoulder belt portion is moved from a resting position at the second seat-side to an operative position at the first seat-side by a rotatory movement of the operating arm.

56. The multi-point seat belt according to claim **55**, wherein the belt-feeding device **(20a, 20b)** is provided with at least one drive apparatus to rotate the operating arm, where the shoulder latch plate **(2, 2a)** is inserted into and connected to the upper buckle assembly **(4, 14, 18)** and the first shoulder belt portion is moved from the resting position at the second seat-side to the operative position at the first seat-side by a rotatory movement of the operating arm when the drive apparatus is activated.

57. The multi-point seat belt according to claim **56**, wherein the operating arm **(20.2a)** consists of

a horizontal portion, to an end of which the guide tube is fastened; and

a vertical portion, an end of which is fastened to the belt housing, having a vertical tube with two openings, facing each other, which is moveable along the vertical portion to adjust a height of the belt housing.

58. The multi-point seat belt according to claim **57**, wherein a radial-adjustable tube **(20.3)** is attached between the horizontal portion and the guide tube, where the first shoulder belt portion is moved from the resting position to the operative position by a radial-adjusting movement of the radial-adjustable tube when the drive apparatus is activated.

59. The multi-point seat belt according to claim **56**, wherein the drive apparatus is operable to return the first shoulder belt portion **(1.1)** from the operative position to the resting position, when a dwell time, predetermined for inserting the main latch plate **(9)** into the main buckle assembly **(9.1)**, is exceeded.

60. The multi-point seat belt according to claim **56**, wherein the drive apparatus returns the first shoulder belt portion **(1.1)** from the operative position to the resting position, when a dwell time, predetermined for inserting the shoulder latch plate **(2, 2a)** into the upper buckle assembly **(4, 4a to 4c, 14, 14a, 18)**, is exceeded.

61. The multi-point seat belt according to claim **56**, wherein the drive apparatus, activated in response to activating a switch, attached in the main buckle assembly **(9.1)**, upon contact with a cam of the main latch plate **(9)**, when inserted therein, is switched off when the operative position is reached.

62. The multi-point seat belt according to claim **56**, wherein the drive apparatus, activated in response to starting an engine of the transport system, is switched off when the operative position is reached.

63. The multi-point seat belt according to claim **56**, wherein the drive apparatus, activated in response to closing a vehicle door of the transport system, is switched off when the operative position is reached.

64. The multi-point seat belt according to claim **56**, wherein the drive apparatus, activated in response to actuating a switch, is switched off when the operative position is reached.

65. The multi-point seat belt according to claim **56**, wherein the drive apparatus is activated when the passenger takes a seat, whereto a sensor is built, where the drive apparatus is switched off when the operative position is reached.

66. The multi-point seat belt according to claim **56**, wherein the drive apparatus, activated in response to depressing x-times the master release button **(84)**, is switched off when the operative position is reached.

67. The multi-point seat belt according to claim **56**, wherein the master release button **(84)** is provided with

release wires connecting to electrical release-motors **(4.2b)** of release buttons of the upper buckle assemblies and

a release wire connecting to the drive apparatus;

where the master release button, when depressed, releases all the latch plates from the respective buckle assemblies and returns the belt-feeding device to the resting position.

68. The multi-point seat belt according to claim **42**, wherein the supplemental latch plate is a belt-detachable latch plate **(25)**, which has a quick-release pin **(25.1)** and a U-shaped portion to house the belt portion of the seat belt which is secured therein by the quick-release pin and detached therefrom by pulling it.

69. The multi-point seat belt according to claim **68**, wherein the seat backrest at the second seat-side is provided with supplemental upper buckle assemblies **(19, 19a, 19b, 19.1 to 19.3)**, which together with the corresponding supplemental upper buckle assemblies at the first seat-side define the pairs of supplemental upper buckle assemblies **(18 / 19, 18a / 19a, 18b / 19b, 18.1 / 19.1 to 18.3 / 19.3)**,

one of which is adapted to a small body proportion of the passenger, lower than the upper buckle assembly; and,

finally, the belt-detachable latch plates, housing both shoulder belt portions, are plug-in connected to that pair.

70. The multi-point seat belt according to claim **69**, wherein the belt-detachable latch plates, when not being used, are stored and secured in a storage box **(25.5)** of the seat.

71. The multi-point seat belt according to claim **69**, wherein the buckle assembly is provided with a coupling fitting **(1.2a, 1.2b)** to receive vibration-dampening energy absorbers.

72. The multi-point seat belt according to claim **56**, wherein a belt-catching member **(20.7, 20.7a)** is attached to the seat backrest to intercept and hold at least one shoulder belt portion when being in the resting position.

73. The multi-point seat belt according to claim **43**, further comprising a height- and width-adjusting mechanism **(27)** consisting of

a pair of tubes **(27.1)** of a seat backrest frame **(3.4d)** having a plurality of vertical locking slots, one pair of which is engaged with a locking handle **(27.5)**, that is pulled to detach therefrom and released to engage with another pair, when adjusting to a height of a body proportion of the passenger;

a frame **(29)** consisting of a pair of outer frame-tubes **(27.2)**, moveable along the inner frame-tubes **(27.1)**, a connecting member of all frame-tubes **(27.2, 27.3)** and a pair of outer tubes **(27.3)**, in which inner tubes **(27.4)** are moveable, biased by tube-springs **(27.6)** and form- and force-locking connected to the locking handle **(27.5)**, where the tube-spring **(27.6)** on a sleeve **(27.7)**, secured by a pin **(27.8)**, protruding through holes of the inner tube **(27.4)**, presses against a spring rest **(27.9** of the outer tube **(27.3)**;

a plurality of horizontal locking slots arranged along one of the outer tubes **(27.3)**; and

at least one buckle-assembly unit **(18.3, 19.3)**, consisting of an upper buckle assembly **(4c)**, to connect to the shoulder latch plate, and a housing **(18.12)**, form-locking connected to the upper buckle assembly, moveable along the outer tubes **(27.3)** and secured by a pawl **(18.10)** biased by a pawl-spring **(18.5)**, engaged with the horizontal locking slot (r) and detached therefrom by pulling the pawl to adjust to a width of the body proportion.

ABSTRACT

A multi-point seat-belt includes two shoulder-belt portions, a lap-belt portion, master release-button, belt-feeding device and multi-attachment points.

Both shoulder-belt portions extend crosswise over the upper-part of the body of a passenger in an X-shape and the lap-belt portion restrains the lower-part thereof when a shoulder- and main latch-plate are plug-in connected to an upper and main buckle-assembly.

Serving as transition-products multi-point seat-belts are defined by conventional three-point seat-belts and new parts.

Anti-submarining seat-belt assemblies prevent the belted passengers from submarining in an accident.

Comfort is enhanced by

- a belt-feeding device, which, when activated, moves the first shoulder-belt portion to extend across over the upper-part thereof,
- the master release-button, which, when depressed, releases all latch-plates and/or returns the belt-feeding device to the home position,
- a radial-adjusting movement of the radial-adjustable tube preventing interference with the head with/without hat, and
- a height-adjustable shoulder-belt-portion guiding deflector.